Installation Instructions For Marelli EFI Conversion With AutoTune Closed Loop

READ ALL INSTRUCTIONS FIRST! If you do not have a H-D® service manual for the year and model of the motorcycle you are working on, get one before starting the installation to use for reference. The factory ECM you are replacing is triggered by signals from the cam position *and* crankshaft position sensor (CPS), while the ThunderMax, like the later Delphi® system, uses only the signal from the crankshaft position sensor. We recommend disconnecting the cam position sensor and installing a new crankshaft sensor and in-tank fuel filter on your (at least) 11-year old motorcycle during installation. Verify charging system operation and battery condition; check both ends of battery cables for clean, tight connections. See Pages 7&8 for special procedures regarding certain model years. *This product is legal in California only for racing vehicles which may never be used upon a highway.*

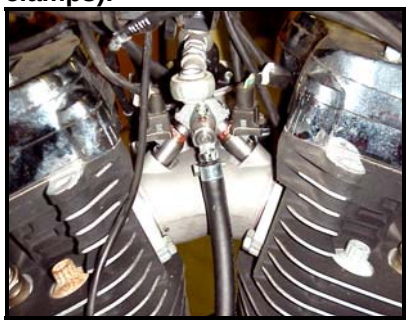
1. Disconnect the battery positive terminal before proceeding to step one. Remove the Marelli intake assembly from the engine. Remove also the top engine mount with the stabilizing link attached to it.

2. The new ThunderMax throttle body and manifold assembly are pre-assembled as delivered. Remove the intake manifold assembly from the throttle body.

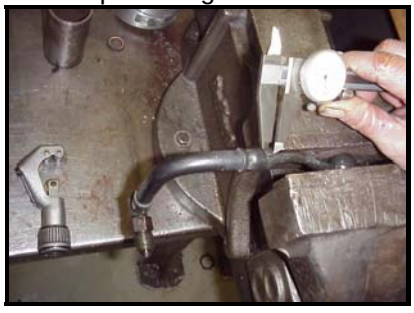
3. Install the manifold assembly using lightly lubricated new intake seals (supplied) and the original intake flanges.

4. Remove the stabilizing link from the top engine mount, noting which side of the link was attached to the engine mount. Re-mount the link to the chassis mount using the supplied 3/8-24 button head bolt, 12pt nut and original washer under the nut as shown (nut up). Tighten to 40 ft/lbs.

5. Attach supplied special high pressure 5/16" EFI hose to fuel rail fitting using supplied EFI hose clamp (the hose and clamps supplied are special high pressure EFI compatible components, **NEVER replace these with standard hose or clamps).**

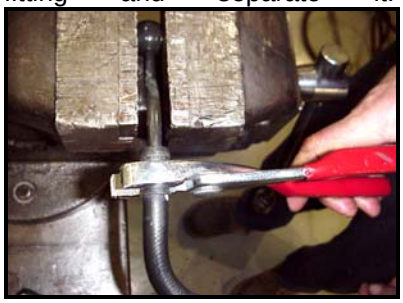


6. The original fuel lines will be retained, but the banjo ends must be removed. Using a pair of dial calipers, mark the crimped factory fitting .210" from the crimp housing.



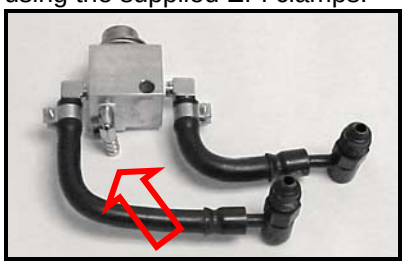
7. Using a tubing cutter, cut through the crimped end.

8. Grasp the fitting with pliers and twist the line loose from the fitting and separate it.

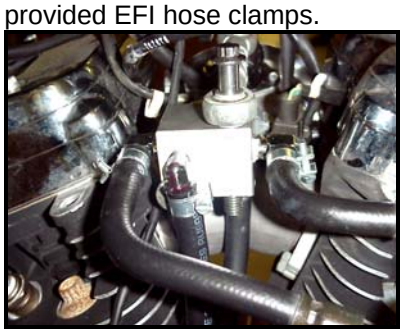


9. Remove the remaining ring from the rubber hose. Repeat this process on the 2nd hose.

10. Attach the fuel supply and return hoses to the manifold using the supplied EFI clamps.

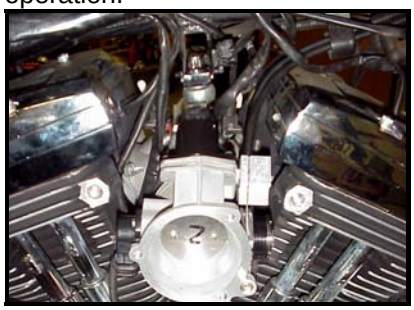


11. Place the manifold in location under the stabilizing link; align with supplied 3/8-16 hex bolt. Route EFI hose from fuel rail to fitting (arrow) on manifold block (trim for best fit; allow gentle loop without permitting hose to kink or touch cylinder fins). Attach with provided EFI hose clamps.

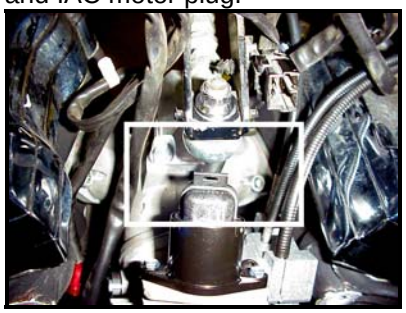


12. Re-install top engine mount with link using provided 3/8-16 hex bolt and existing nut and washers on left side (tighten to 40 ft/lbs); use supplied buttonhead bolt and 12pt nut for the right side link (nut on top).

13. Install throttle cables and throttle body assembly. Attach harnesses for TPS, MAT sensor and IAC motor. Adjust throttle cables for proper closed free-play and idle to wide-open operation.



14. Verify clearance between buttonhead stabilizing link bolt and IAC motor plug.



15. Install air cleaner (follow instructions included with air cleaner kit).

16. Install fuel tank. Re-attach fuel hoses to tank.

17. **For steps 17 & 18 the battery <u>positive</u> cable should still be disconnected.** There are several relays in the wiring system. Locate and remove the **"ECM Power Relay"** usually under seat. This will be replaced with supplied relay **<u>AFTER</u>** <u>the battery cable is reconnected.</u> This specially modified relay is configured with a "stay alive" circuit, required for your new ECM. <u>2000-2001 models, see special instructions on page 7 before proceeding.</u>

18. Remove factory ECM and replace with supplied ThunderMax ECM <u>(1995-1996 model years, perform ground wire addition explained on page 8 before installing ECM)</u>. Route communication cable plug to allow for easy access. After the ECM is plugged in, connect the battery positive cable, then install the new ECM Power Relay. If the lights come on or the fuel pump runs upon relay connection, the wrong relay was replaced in step 17 (correct this).

Installing With AutoTune

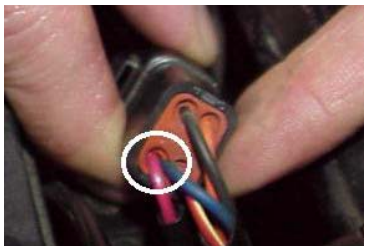
19. If the exhaust system you are using is not equipped with oxygen sensor bungs, bungs will need to be added to the exhaust pipes. Bungs must be located within 3"-6" from the cylinder head. Install supplied wide band oxygen sensors in the front and rear exhaust pipes. Route and tie down the sensor harnesses away from the engine.

20. To mount the closed loop module, pick a suitable location that will allow the power/data plug to easily reach the bike's diagnostic port plug, and allow the oxygen sensor harnesses to reach the sensor plugs. Secure with wire ties or 2-sided foam tape (orientation of the module is not important). Connect the sensors to the closed loop module. **The sensor wiring harness for the rear cylinder sensor is shorter and can be easily identified by black tracers on all of its wires.** It is very important to install this correctly or the engine will perform poorly!

Special Procedure for AutoTune Wiring on Marelli Bikes:

Your AutoTune module is designed to communicate with the ThunderMax through the bike's Data Link connector. This port is also where the AutoTune draws its power. However, on 1997-2001 model Big Twins, the 12 volt terminal (#4 in the Data Link plug) is "hot" at all times, not upon "key-on" as are 2002 and later (Delphi) bikes. The Data Link must be rewired to provide power for the AutoTune module only when in the "key-on" position or battery drain will result.

To rewire this plug: Identify the "Accessory" plug, located under the seat nose, just below and to the right of the frame's backbone where it intersects with the frame side rails. This plug has 4 wires routed to it. Locate the blue wire in the #1 position.
Remove the rubber seal plug (or, if there are any accessories plugged into the accessory port, temporarily unplug the accessory). Remove the socket lock and push the #1 terminal and wire out of the plug. Clip off the terminal end and install a new (supplied) terminal on the blue wire along with the supplied length of orange wire (crimp together). Reinstall the terminal



into the #1 port of the accessory plug and reassemble the plug. Remove the lock from the Data Link plug and push the red/orange wire and terminal from the #4 position. Route the orange wire from the accessory plug to the Data Link plug. Crimp the supplied terminal to the orange wire and install it into the Data Link #4 plug. Cover the end of the original red/orange "hot" wire terminal end, and tuck the covered terminal into the harness sleeve.

Your Data Link plug will now be wired "hot" through the key switch.

You may choose to source your "key-hot" wire from another location; certainly your choice. Whatever you choose, the wire in the #4 Data Link plug must be changed to a "key-hot" wire or a dead battery will be the result.

21. Plug the closed loop module into the power source (Data Link) on the bike. It is through the data port that data from the AutoTune module is transferred to the ThunderMax. A 'Y' harness is available to keep an open data port if desired.

SPECIAL PROCEDURE REQUIRED FOR ECM INITIALIZATION UPON FIRST TIME KEY-ON POWER-UP! See Step 24.

<u>Before starting the engine for the first time, Thoroughly check motorcycle for</u>:

Fuel leaks at all line connections including the pressure regulator block, fuel rail fittings and all hose connections; tight battery and ground connections; proper throttle cable adjustment (throttle closes and opens fully with proper free-play), smooth throttle operation (ensure that the throttle returns to the idle position quickly and automatically), and a full fuel tank with fresh high-test fuel. Perform the next steps after all systems have been verified as operational from re-assembly.

Confirm that a base map was loaded into your module by Zipper's for your application:

____ **Base Map NOT Loaded**

____ **Base Map Loaded**

Map # _____

If a base map was loaded by Zipper's, skip step 23.

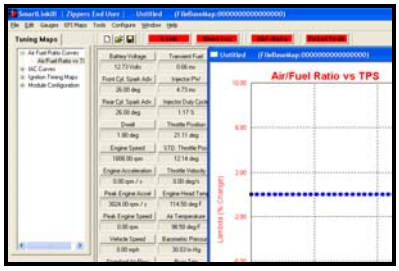
22. Insert the SmartLink CD into your computer. SmartLink will automatically open the InstallShield Wizard when the computer finds the CD-Rom. Follow the instructions and install the software on your computer. After installation, attach the serial cable to your computer and the ThunderMax ECM. (If you do not have a serial port on your computer for the communication cable, you will need to use a USB to Serial converter; an inexpensive converter is available from Zipper's, #372-000. Install the drivers at this time; follow the instructions given by the manufacturer of the converter.) Make certain that the cable is routed away from any part of the motorcycle that generates heat.

23. **If a base map was NOT loaded**, select and load a base map that best matches your engine combination and exhaust. Install the SmartLink software to your hard drive, open the software and consult the SmartLink Tuning Manual by clicking on the [Help] menu on the toolbar, then [SmartLink Tuning Manual]. Proceed to section 3 and follow the instructions for choosing and loading a base map. After the base map is loaded, while linked, go to the Tuning Tree, select [Module Configuration] [Basic Settings] and click on [Speedo Cal] and set this to 4352. Close the [Basic Settings] window and click [Configure] on the toolbar, then click [Closed Loop MODULE Settings] and verify that the "Closed Loop Processing" boxes are checked

in both the MAP and MODULE sides of this window.

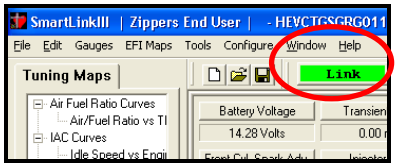
24. **"Initialize" the ThunderMax ECM.** With the handlebar switch in the 'ON' position, cycle the key switch on and off 3 times, leaving the ignition on for 30 seconds each cycle. DO NOT start the engine or move the throttle at this point. During this time, the fuel pump will also prime and pressurize the system. Check the system for fuel leaks again. After 3 on/off cycles, start the bike 2 times, let it settle at idle for 10 seconds; the idle should be smooth and even. If so, shut down and proceed to Step 25. **Note: Anytime the processor has been powered down (battery or special ECM Relay disconnected) the ECM will need to be re-initialized in the manner mentioned above.**

25. Open the SmartLink software package by selecting the icon placed on your desktop. The following picture is what will appear when SmartLink opens for the first time.

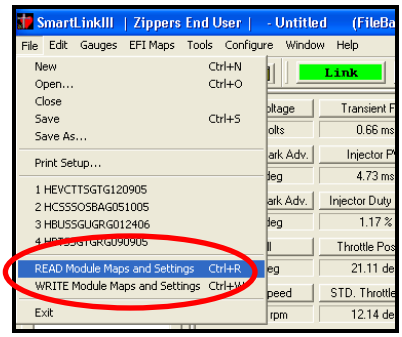


26. Turn the key switch to the "Ignition" position, making certain the "RUN / OFF" rocker switch (Kill Switch) on the handlebar controls is in the "RUN" position.

27. Select the "Link" Button in the SmartLink software.



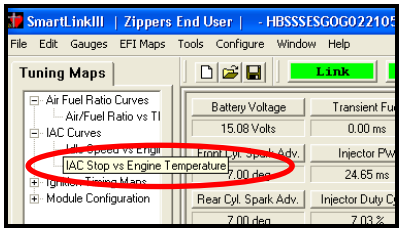
28. Read the map that is installed in the ThunderMax ECM by selecting [File] then [Read Module Maps and Settings] on the SmartLink toolbar. This will copy the map file loaded into SmartLink with the map file loaded into the ThunderMax ECM.



29. Before restarting the engine, from toolbar click **[Monitoring] [Show Gauges]**. The "Engine Speed", "Engine Head Temp", "IAC Position", "AFR Front", AFR Rear" and "AFR Target" gauges are automatically formatted and are shown on the screen. Additional gauges can be created if desired (see SmartLink Tuning Manual under Help menu), but the above gauges are most helpful during initial set up. You may select any gauges that you deem important; if too many are chosen your screen may appear cluttered. Experiment with the gauges but always display the gauges mentioned above.

30. Select the "Monitor" button to active the gauges. It is located beside the "Link" button and will turn green when the monitor gauge function is live. The gauges will be displayed if they were not already on the screen.

31. Now select the IAC Stops vs. Engine Temperature page. Strike the spacebar to show the actual values of the tuning block.



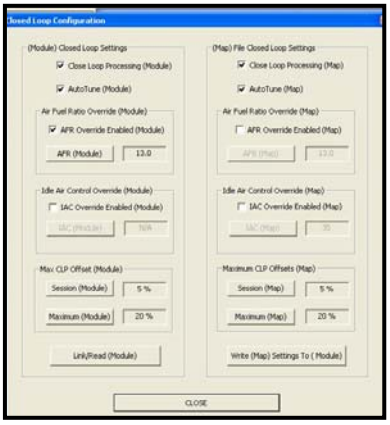
32. Make certain that the motorcycle is in Neutral and the engine is cold, then start the engine. If the engine idle is stable after 10-15 seconds, shut the engine off and re-start it twice more. Once the engine idle is stable after 15- 20 seconds, select the "IAC-Auto" button (Idle Air Control Auto Adjustment). Allow the "IAC-Auto" function to run at idle until the engine head temperature reaches 275 degrees. After reaching temperature of 275 degrees, the "IAC-Auto" function automatically shuts off. You can terminate this function at any time, and re-run it at a later time if you wish.

33. Unlink the SmartLink software from the ECM (click the green [Link] button, turns red indicating unlinked from ECM), and physically remove the Communication Cable from the ThunderMax ECM.

WARNING: ANY TUNING OPERATION INVOLVING ACTUAL OPERATION OF THE MOTORCYCLE ON PUBLIC STREETS OR HIGHWAYS IS DANGEROUS! FULL ATTENTION TO TRAFFIC CONDITIONS SHOULD ALWAYS BE YOUR FIRST FOCUS ANYTIME YOU ARE OPERATING A MOTORCYCLE ON PUBLIC ROADS. INATTENTION TO CONDITIONS CAN LEAD TO ACCIDENTS AND PERSONAL INJURY INCLUDING DEATH.

CLOSED LOOP PROCESSING

Your ThunderMax was programmed for closed loop processing during the map loading process. Your SmartLink software will allow you to set Air/Fuel tuning parameters for your ThunderMax and its installed base map when the AutoTune module is installed and AutoTune program is enabled. To set Target AFR and AutoTune Limits, go to the toolbar and click **[Configure] [Close Loop MODULE Settings]**.



The Closed Loop Configuration dialog page opens (above); the right side shows the default MAP settings stored in the MAP file (settings are applied to the installed base map during the 'Closed Loop Format' conversion performed by SmartLink), while the left side shows what the module is currently set to (unadjusted, these settings will mirror MAP's settings).

The un-highlighted left 'MODULE' side of the page allows editing of those settings within the module for tuning purposes. To edit module settings, click the **[Link/Read (Module)]** button (left side highlights/active). You can now edit these settings within the module should you want to change any of the settings from the 'MAP' default settings.

Closed Loop Processing (Module) – Check **[ON]** to enable closed loop processing. During closed loop processing, the ThunderMax module processes feedback from the oxygen sensors to adjust the fuel volume at all points by creating "offset" pulse width values from the installed 'base map' fuel values (points). The 'static' base map is dynamically used by the ThunderMax module and the AutoTune's active (closed loop) feedback system. This system optimizes the fuel points to fit the target air/fuel ratio through 'learned offset points'. These 'learned offset points' are stored within the ThunderMax and are used in conjunction with the base map. The 'base map' fuel points are not being adjusted by either the AutoTune or ThunderMax modules.

AutoTune (Module) – Check **[ON]** to allow the AutoTune module to provide data used for AFR adjustments via map point offsets mentioned above. Un-checked, fuel points will be adjusted to the last learned offset points, or if no learning has occurred, to the original base map points.

Air Fuel Ratio Override (Module) – You can specify an across-the-board AFR that the ThunderMax will adjust to. Clicking this box and changing this number overrides ALL 'Air/Fuel Ratio vs. TPS' pages at all RPM's. To target *specific* Air/Fuel Ratio RPM ranges and throttle positions, leave this box unchecked and edit the individual 'Air/Fuel-TPS @ rpm' map pages located under the 'Tuning Maps' tree.

Idle Air Control Override (Module) - Check [OFF]. This setting should not be checked on except for diagnosing a particular type of supported problem or during tuning on a load cell dyno. Changing this setting will lead to starting and idling problems.

Maximum CLP Offset (Module) – **[Session (Module)]** button sets the AFR *maximum learning correction* from the base map's fuel setting *per session* by percentage (range is 0-10%). A 'session' is defined as the period of time from engine on to engine off (per cycle). **[Maximum (Module)]** button sets the *total* AFR maximum learning correction from the base map's fuel setting by percentage (regardless of number of sessions; range is 10-25%). Unless your application is a considerable mismatch to the installed base map, the default settings of 5 and 20 percent are sufficient for most AFR corrections.

You should always pick the best possible map match during the selection of your base map. The theory behind this is to reduce the range and time the closed loop system needs to learn offsets (corrections) for the target AFR. If your map selection is a poor match to the application, the amount of learning needed will be significant. Review the parameters of your base map vs. available base maps under 'Base Maps Listing' to ensure you have the best map match and the latest version of the map.

TIPS AND GENERAL INFORMATION

Several support features are located under the [Help] menu:

- A comprehensive tuning manual
- Links to allow transmission of module and map data via E-mail directly to ThunderMax support
- Links to allow transmission of monitor logs (recorded riding sessions) via E-mail directly to ThunderMax support
- Links to Thunder-Max.com web site for support documents and videos

TMax Control Center provides a snapshot of AutoTuned fuel flow adjustments, RPM time logs in increments of 100 RPM's, engine temperature logs and diagnostic codes. Valuable information about the condition of your tune and how you ride. **AutoMap**, located within the TMax Control Center, feature creates a custom base map based on AutoTuned fuel flow adjustments. Create a custom base map with just a few clicks!

When the SmartLink program is opened, it will automatically retrieve and open the last map that was open.

Any time you link to your motorcycle: *Read* the map that is installed in the ThunderMax ECM by selecting **[File]** then **[Read Module Maps and Settings]** on the SmartLink toolbar. This will synchronize the map file loaded into the ThunderMax ECM with the SmartLink software.

Accel Fuel is be used to tune throttle response (go to [Module Configuration] [Basic Settings]).

AFR Correction vs. Engine Temperature page is used to adjust warm-up AFR's. If the engine requires more fuel during warm-up (start to 200°), use this function to adjust. See SmartLink Tuning Manual for procedures.

AFR vs. Engine Temperature - During warm-up, the AFR on both cylinders will show richer than the target AFR at operating temperatures; this is a normal part of the warm-up map. No permanent changes to AFR targets and adjustments are made below 200 degrees. See SmartLink Tuning Manual for applications and procedures.

Air/Fuel-TPS @ RPM These pages reflect selected targets of AFR to throttle position at every 256 RPM when system is in closed loop. Example: if you desire a leaner mixture for added fuel economy then you can easily make multi-tiered AFR targets at specific throttle positions and RPM's that will be learned during riding sessions.

During warm-up, the AFR on both cylinders will be richer than the target AFR at normal operating temperatures; this is a normal part of the warm-up map. AutoTune and its targets are inactive below 200 degrees.

Writing new or modified maps to the module requires the system to be re-initialized, and any existing learned fuel and IAC adjustments to be cleared (Map Editing, clear). Linking and editing an existing map within the module does not require above steps.

System Updates are available through SmartLink with an internet connection. Software, Firmware and Map updates can be downloaded; check frequently for updates.

In-Tank Fuel Filters should be inspected as a part of routine maintenance. The filter is small and one bad load of fuel can clog it. The factory recommended service interval is 25K miles.

Fuel Pressure Should Be Checked during periodic service; this is also the first thing to check should you experience sudden or gradual decreasing performance. For any EFI system to operate properly, your fuel system should build and maintain 55-62 PSI of fuel pressure; your dealer can perform this simple test quickly.

The factory ECM you are replacing is triggered by signals from the cam position *and* crankshaft position sensors, while the ThunderMax uses *only* the signal from the crankshaft position sensor. We recommend disconnecting the cam position sensor, and installing a new crankshaft position sensor and in-tank fuel filter on your (at least) 11-year old motorcycle during installation. Verify charging system operation and battery condition; check both ends of battery cables for clean, tight connections.

Save your edited maps to your hard drive using the [Save As] command. Document the changes in [Map Notes] located under [EFI Maps on the toolbar. These notes are stored with the saved map; remember to edit them when making changes for future reference.

***DON'T* unplug the ECM** without first removing the "System Relay". "Hot Swapping" the module can damage the electronics by spiking the circuits. Don't forget to reinitialize the IAC using step 24 above any time power is interrupted to the ECM.

***DON'T* attempt to program** the ECM or start the engine when the ECM is in any position other than its natural installed position. There is a bank angle switch within the ECM that will interrupt power, corrupting programming.

Oxygen Sensor Care Items that can damage or shorten the life of your sensors:

- Leaded fuel – Race fuel
- Oil deposits from oil consumption problems
- Excessive moisture exposure
- Extreme heat

Damaged sensors will have a significant effect to the performance of the motorcycle and should be replaced. Replacement sensor P/N is 309-355.

Special Procedures For Certain Year Installations

2000 and Early Model 2001 Motorcycles – Page 7
1995-1996 Model Motorcycles – Page 8

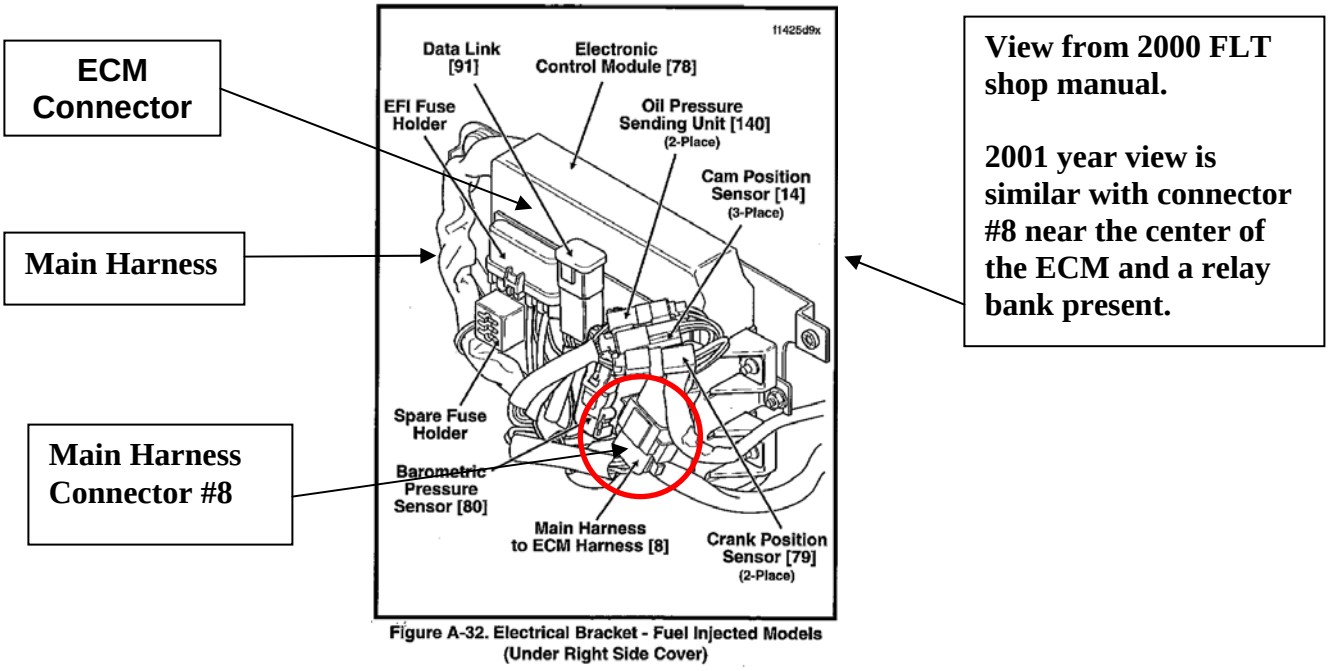
2000 and Early Model 2001 Motorcycles

For the year **2000 and some early 2001** FL models, the **Vehicle Speed Sensor (VSS)** signal output wire from the speedo terminates at the 8-pin main harness connector (see illustration below), #**8A, pin 5**. There is no connection from there to the ECM and therefore no **VSS** signal to the **ECM**. This lack of data renders the ThunderMax's Automatic Idle Air Control Correction features inoperable and must be corrected. For late-year **2001** FL models, this same VSS signal output is continued to the ECM from connector **#8- pin 5** to **ECM pin 8** (White/Green color wire, no modification required). Simply view the Main Harness Connector to verify if the wire is needed.

The VSS wire is added to the harness as follows;

1. Remove the **ECM relay** and unbolt the **ECM bracket** from the bike.

2. Disconnect the main harness from the ECM and pull the rubber boot back to expose the **ECM connector**. Clip any wire ties and remove the screw that secures the plastic terminal cover and remove the cover.


ECM Connector
Main Harness
Main Harness Connector #8
f11425d9x
Data Link [91]
Electronic Control Module [78]
EFI Fuse Holder
Oil Pressure Sending Unit [140] (2-Place)
Cam Position Sensor [14] (3-Place)
Spare Fuse Holder
Barometric Pressure Sensor [80]
Main Harness to ECM Harness [8]
Crank Position Sensor [79] (2-Place)
View from 2000 FLT shop manual.
2001 year view is similar with connector #8 near the center of the ECM and a relay bank present.
Figure A-32. Electrical Bracket - Fuel Injected Models (Under Right Side Cover)

3. Slide a common plastic wire tie through the plastic **main harness cover** toward the **ECM connector**. **(See Fig. A-32, Main harness to ECM harness [8])** Using a piece of tape, attach 2" of the new wire to the wire tie and carefully pull it through the plastic wire cover. From there it can easily be routed with the existing wires to connector **#8B, pin 5**. Use a magnifying glass if necessary to identify terminal location (numbers are on connector). Terminals 72326-95 (ECM) and 72191-94 (Main Harness Connector) are included; identify the correct terminals and use the correct tool to crimp the terminals on the wire.

NOTE: Alternately, the new wire may be routed outside of the plastic harness cover and wire tied to the harness.

4. Separate connector **#8** and remove the plastic retainer and rubber seal from side **B** where the terminal will be installed (carefully pry out with a small screwdriver). Use care to insert the new wire terminal into the **pin 5** opening so that it's positioned correctly. Replace the plastic retainer then re-install the seal last so as not to twist or damage it. Re-connect connector ends **8A to 8B**.

5. Insert the **ECM** end of the new wire into the **ECM connector pin 8** and replace the cover. Use wire ties as needed. **Use care** when inserting the new terminal so that it's positioned the same as the existing terminals. Note the tabs on the terminal which lock into the connector. Make sure they are tapering outward and not flattened.

See Next Page For 1995-1996 Model Instructions

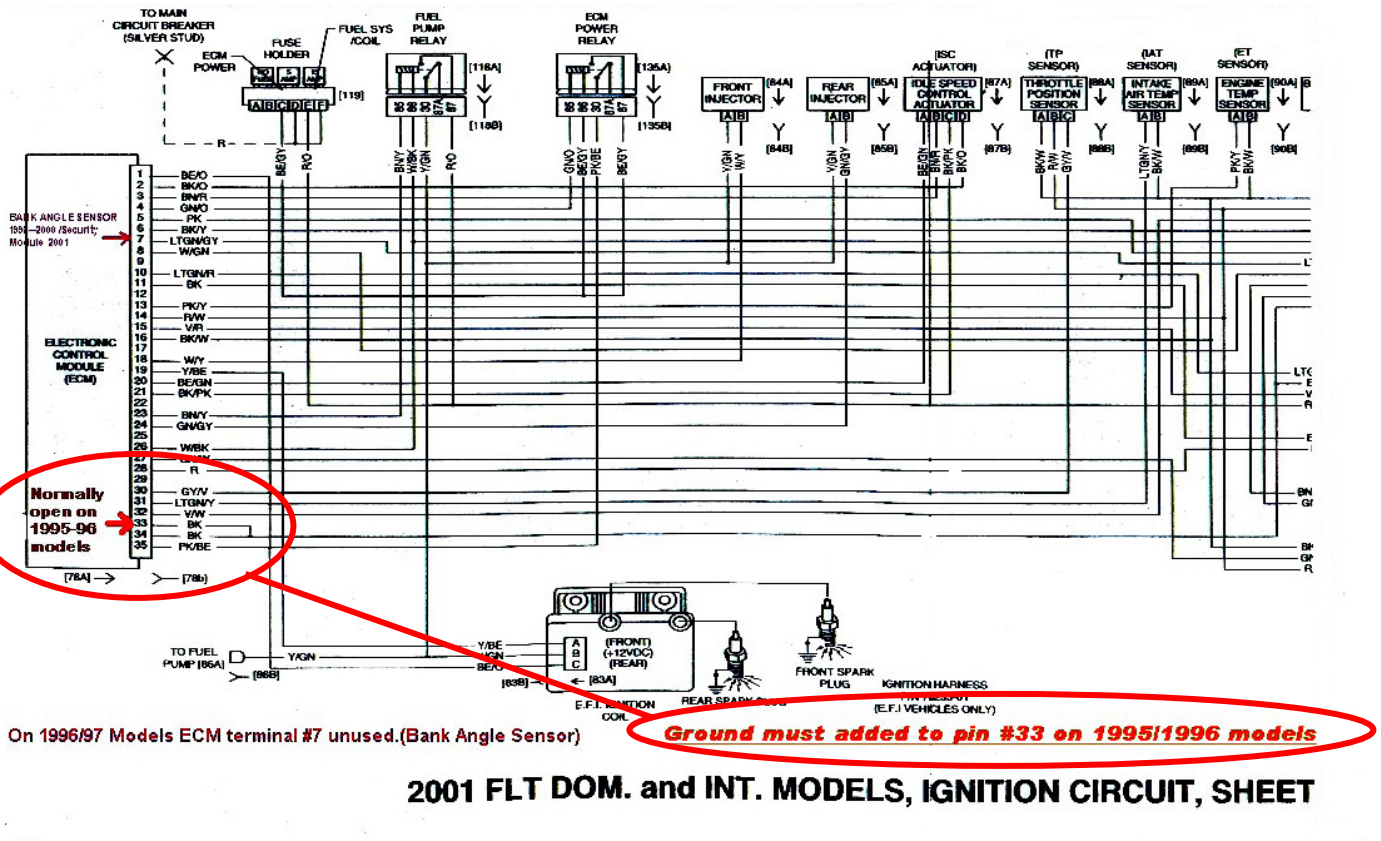
Special Procedures For Certain Year Installations

1995-1996 Model Motorcycles

1995 and 1996 model motorcycle must have a ground wire added to the main ECM terminal connector at Pin 33 (standard on 1997-2001 models). Parts required are (1) terminal connector H-D # 72326-95 and a length of black wire.

Crimp the terminal end to the wire and add the wire to the open port #33 on the main harness connector. Attach the other end to a suitable ground source or carefully splice it to the black wire located at pin 34 (see diagram below).

Once this ground wire is added, proceed with step 20.


Normally open on 1995-96 models
On 1996/97 Models ECM terminal #7 unused.(Bank Angle Sensor)
Ground must added to pin #33 on 1995/1996 models
2001 FLT DOM. and INT. MODELS, IGNITION CIRCUIT, SHEET

THUNDER MAX
EFI made simple.

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